

We Claim:

1. A fixation apparatus for being fixed to a bone to keep the bone in a fixed position relative to the apparatus during a healing process therefor, the fixation apparatus comprising:

5 at least one bone pin having a proximal end and a distal tip end configured for tightly gripping onto the bone;

 a pin positioner that supports the pin to allow a user to manipulate the positioner external of a patient's body for positioning the pin to be advanced into engagement with the bone; and

 a pin holder of the positioner for carrying the pin and having a pin advance assembly operably connected to the pin to allow a user to shift the pin in an advancing direction to bring the distal tip end into gripping engagement with the bone, the pin advance assembly being integrated with the pin holder for staying with the positioner during the healing process.

15 2. The fixation apparatus of claim 1 wherein the pin advance assembly includes a locking mechanism including locking surfaces which allow the user to shift the pin to an engaged position with the bone with the locking surfaces engaged to substantially keep the pin from shifting in a retracting
20 direction opposite the advancing direction and away from the engaged bone.

 3. The fixation apparatus of claim 1 wherein the pin advance assembly includes a ratcheting mechanism between the pin holder and the pin which

substantially keeps the pin from shifting away from the advanced position thereof.

5 4. The fixation apparatus of claim 1 wherein the pin holder includes a housing having a through opening with the pin proximal end projecting out from the housing opening, and the pin advance assembly includes cam surfaces that allow a user to push on the pin projecting proximal end for shifting the pin in the advancing direction thereof and providing the user with optimal tactile feedback on secure engagement between the pin distal tip end and the bone.

10 5. The fixation apparatus of claim 4 wherein the pin advance assembly includes a lever, and stop surfaces and the cam surfaces being on the lever and the pin, and

15 a biasing mechanism that urges the stop and cam surfaces together with a predetermined bias force so that pushing the pin proximal end causes the lever to shift against the bias force with the bias force sufficient to keep the pin from retracting away from the bone upon release of the pin.

20 6. The fixation apparatus of claim 1 wherein the pin positioner and the pin holder include a releasable attachment therebetween, and the pin holder comprises modules that carry one or multiple pins and pins of different sizes which allows a user to select the number and size of bone pins to be carried by the positioner.

7. The fixation apparatus of claim 6 wherein the pin positioner comprises at least one rigid member having opposite ends, and the releasable attachment includes interengaging mounting flanges of at least one of the ends of the positioner member and the pin holder module for mounting the module at a predetermined position on the rigid member end, and a detent between the rigid member end and the module operable to releasably secure the module at the predetermined position thereof on the rigid member end with the pin retracted away from the bone.

8. The fixation apparatus of claim 1 wherein the pin positioner comprises a plurality of rigid members having a plurality of fixed positions relative to each other to allow the associated pin holders to be oriented at various different positions relative to each other about the bone to obtain different angles of orientation for the bone pins carried thereby relative to the bone.

9. The fixation apparatus of claim 1 wherein the pin advance assembly includes a fine adjustment device operable to advance the pin with fine force adjustments and with high resolution feedback of pin-to-bone engagement forces to the user.

10. A bone fixation apparatus comprising:

at least one elongate bone pin having a proximal end and a distal bone gripping end;

an external pin positioner member for supporting the pin in gripping

engagement with a bone from external of a patient's body; and

a pin advancing mechanism mounted to the positioner member having an opening through which the pin extends for being shifted into advanced positions of the pin and into engagement with a bone upon application of manual force to the pin proximal end, and an adjustment device which allows for fine adjustments to be made to the advanced positions of the pin for fine tuning of engagement forces between the pin and bone.

11. The bone fixation apparatus of claim 10 wherein the pin advancing mechanism includes a housing with the opening for the pin formed therein, and the adjustment device is a screw member threaded in the opening for being advanced into the housing with turning thereof.

12. The bone fixation apparatus of claim 10 wherein the advancing mechanism comprises a ratchet assembly to provide coarse adjustments to the pin advanced positions and which is substantially fixed to the pin upon removal of manual force therefrom, and the fine adjustment device comprises a screw device for being turned and advanced into engagement with the ratchet assembly to fine tune the advanced position of the pin.

13. The bone fixation apparatus of claim 12 wherein the advancing mechanism includes a housing fixed to the positioner member and having the opening which receives the screw device threaded therein, the housing

further having a slot, and the ratchet assembly includes a follower that is engaged by the screw member with turning thereof for being advanced in the slot, the slot having a predetermined length to define a predetermined amount of fine tune adjustment for the pin.

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14. The bone fixation apparatus of claim 10 wherein the advancing mechanism includes a release member and a plurality of teeth along the bone pin with the release member biased with a predetermined bias force into engagement with the teeth to keep the advanced pin from retracting away from the bone.

15. The bone fixation apparatus of claim 14 wherein the release member includes one of a button that is shifted in a linear direction against the bias force and a lever that is pivoted against the bias force to allow the pin to be advanced into engagement with a bone.

16. A bone fixation system for being rigidly attached to a bone, the bone fixation system comprising:

a plurality of bone fixators each including at least one pin positioner member and at least one pin supported by the positioner for being advanced into gripping engagement with the bone;

rod mounts at predetermined positions along each of the positioner members so that there is a predetermined angular spacing therebetween; and

a pair of rods for interconnecting the bone fixators received by the rod mounts at the predetermined positions of the fixator positioner member with separation of the rods from a generally coplanar relation with the bone having the pins of the fixators in gripping engagement therewith being substantially optimized by the predetermined angular spacing of the rod mounts of the positioner members to provide stability of the interconnected fixators attached to the bone.

17. The bone fixation system of claim 16 wherein the positioner members have an arcuate configuration to keep spacing of the positioner members from the bone to a minimum.

18. The bone fixation system of claim 16 wherein the predetermined angular spacing between the rod mounts is approximately 80 degrees.

19. The bone fixation system of claim 16 wherein the positioner members each include a rigid body having end portions thereof, the rod mounts include flexible receptacles at the end portions of each of the bodies, and an independent clamping member for each of the receptacles that clamps on the flexible receptacles for fixing the rods therein.

20. The bone fixation system of claim 16 wherein the rod mounts each comprise a resilient ball having an opening in which one of the rods is received and a locating portion of the ball which keeps the opening thereof

accessible for receiving the rod therein.

21. The bone fixation system of claim 16 wherein the bone fixators each include a pair of pin positioner members that each support at least one bone pin and that are adjustably connected to each other with the rod mounts being on one of the positioner bodies.

22. A bone fixation apparatus comprising:

a plurality of bone pins;

a pair of pin positioner members each supporting at least one bone pin and having arcuately configured bodies;

an adjustable connection between the arcuate bodies to allow the pins supported thereby to be angularly shifted about a bone for obtaining different angles of orientation to the bone; and

pin holders attached to the bodies in which the pins are carried for being advanced into gripping engagement with the bone.

23. The bone fixation apparatus of claim 22 wherein the adjustable connection comprises a plurality of spaced apertures along at least one of the positioner bodies and a connecting member mounted to the other positioner body for being secured in a selected one of the spaced apertures.

24. The bone fixation apparatus of claim 23 wherein the adjustable connection comprises a set of spaced apertures along both of the positioner

bodies with the apertures in at least one of the sets being threaded and the connecting member being a threaded fastener.

5 25. The bone fixation apparatus of claim 22 wherein the adjustable connection comprises a tongue and groove on respective positioner bodies for guiding sliding movement of the bodies between different connected positions relative to each other.

0 26. The bone fixation apparatus of claim 22 wherein the bodies have a predetermined cross-sectional configuration that is other than flat to increase the moment of inertia and strength thereof.

5 27. The bone fixation apparatus of claim 26 wherein one of the bodies has a generally U-shaped cross-sectional configuration and the other body has a generally T-shaped cross-sectional configuration.

20 28. The bone fixation apparatus of claim 22 wherein the pin holders are releasably connected to one of the ends of each of the pin positioner bodies, the adjustable connection allows the bodies to be detached from one another, and one of the pin positioner bodies includes a pin opening at an opposite end to the one thereof for removably receiving a pin fixed therein with the bodies detached from each other.

29. The bone fixation apparatus of claim 22 wherein the pin holders are

modules carrying one or multiple bone pins with the modules releasable connected to one of the ends of each of the positioner bodies.

5 30. A method of fixing bones with bone fixators having bone pins for engaging the bones, the method comprising:

manipulating a pin positioner supporting the bone pins to position the pins for being engaged onto a bone;

manually pushing at least one displaceable pin through a pin holder at one end of the positioner to cause the pin to shift in an advancing direction into engagement with the bone at an advanced position thereof; and

automatically locking the pin in the advanced position thereof in the pin holder upon release of the manual pushing force applied thereto.

15 31. The method of claim 30 including displaceably supporting another pin with the positioner, and

repeating the manual pushing and automatic locking steps with the other displaceable pin through another pin holder at the other end of the positioner.

20 32. The method of claim 30 wherein the one pin is manually pushed via incremental ratcheting of the pin to the advanced position thereof.

33. The method of claim 30 including making fine adjustments to the

advanced position of the pin and providing high resolution of pin-to-bone engagement forces to a user.

5 34. The method of claim 33 wherein the fine adjustments are made by turning a screw device, and

locking the screw device against turning after the fine adjustments are made.

10 35. The method of claim 30 wherein the pin positioner is manipulated by one hand of a user with fingers of the one hand used to manually push the pin in the advancing direction to provide for one-handed operation of the bone fixator.

15 36. The method of claim 30 wherein the pin positioner comprises a pair of adjustably connected members each having a pin holder at an end thereof, and

adjusting the members to each other to change relative positioning of the pin holders and the pins carried thereby.

20 37. The method of claim 30 including rigidly connecting the pin positioner to another pin positioner having bone pins advanced into engagement with the bone or another bone.